Title: Simulating Haemorrhage in Medical Students using a Lower Body Negative Pressure Chamber; Measuring the Consequences for Tissue Oxygenation

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Abstract

Introduction This article is a descriptive report of a novel way of demonstrating the cardiovascular response to progressive haemorrhage using simulation.

The aim of the simulated haemorrhage is to improve the understanding of the cardiovascular response to haemorrhage and demonstrate 'live' the body's response to reduced venous return.

Method Phase 1 of a 'simple' haemorrhage is simulated in 6 medical students by applying sub-atmospheric pressure to the lower body using a lower body negative pressure (LBNP) chamber. The sub-atmospheric pressure causes 'pooling' of blood in the vessels of the legs and pelvis, which reduces venous return thus mimicking the

effects of haemorrhage. Parts of this method have been described elsewhere (1). A range of cardiovascular parameters are monitored throughout the demonstration to allow students to observe the integrated response to 'progressive haemorrhage'. Stroke volume is monitored using a portable ultrasound machine, heart rate is measured from an ECG trace and blood pressure using an automated sphygmomanometer. Skeletal muscle and brain oxygenation, which in this context reflects changes in blood flow, is assessed using Near Infrared Spectroscopy (NIRS).

Results Simulated haemorrhage reduces venous return, thus reducing stroke volume by Starling's law of the heart (2) and ultimately reduces arterial pulse pressure. The body's initial response (mediated by the baroreceptor reflex) to this is an increase in heart rate to maintain mean blood pressure (3) in the face of a falling cardiac output. The students also calculate the changes in total peripheral resistance and are able to see the consequences for brain and skeletal muscle oxygenation.

Conclusion Durham University Medical Programme uses simulation in a novel way to reinforce didactic teaching of the cardiovascular response to haemorrhage utilising a LBNP chamber.

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